ADAMANT: Adaptive Manipulation for Tasks, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

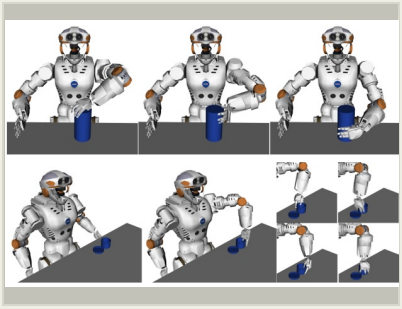
Robots will play an important role in NASA's upcoming missions to the Moon and beyond. More than just remote sensors, they will be expected to manipulate their environment in a complex and useful way - carrying objects, using tools, and assisting the crew with various physical activities. NASA has been developing world-class dexterous end effectors for years. Unfortunately, developing software to fully utilize such hands is very challenging. Grasping strategies tend to be highly dependent on object models and localization, or reliant on a good connection to an operator. As any of these deteriorate, even simple grasping of known objects becomes unreliable. The environment or the object's intended use can influence how to grasp it. The best way to pick up a tool will depend on whether it is to be transported to another location, handed to a crew member, or used as a tool.

Previously with NASA, TRACLabs developed robot control software called CRAFTSMAN that includes trajectory generation, simple action-sequencing capabilities, and a method for parameterizing, encoding, and visualizing task descriptions. CRAFTSMAN supports robot-independent task descriptions, but grasp strategies are still robot-specific open-loop waypoint sequences, subject to the problems listed above. In this work, we propose to extend CRAFTSMAN to handle grasping as a task-informed behavior, using sensor data and object models when possible to identify grasp sites. This new system, called ADAMANT (ADAptive MANipulation for Tasks), will help an operator to determine the best option for acquiring an object. The result will be a robot grasping interface that is more intuitive to use than current technology and will produce more robust robot behavior. This will reduce the cognitive load on remote robot operators by eliminating the need for run-time manual adjustments. By removing the details of grasp strategy from high-level planning, the design of action sequences will also become easier.

Anticipated Benefits

This work is immediately applicable to NASA robots such as Valkyrie, SPDM, and Resource Prospector. Future NASA robots will perform autonomous repair tasks on satellites or the Deep Space Gateway, and caretaker robots will maintain dormant facilities. Robots will also assist humans with tasks such as habitat construction or geological exploration. The proposed system will greatly improve the capabilities of these robots and the interfaces that support them.

TRACLabs has an existing R\&D partnership with major automotive suppliers to integrate CRAFTSMAN into their plants. The first installation went live in September 2017 and operates continuously. The proposed research will be immediately applicable to their stated goals of deploying flexible workcells world-wide. TRACLabs is a member of the ROS Industrial Consortium (ROS-I), where this technology will be of interest to numerous consumers of advanced robotic technology.



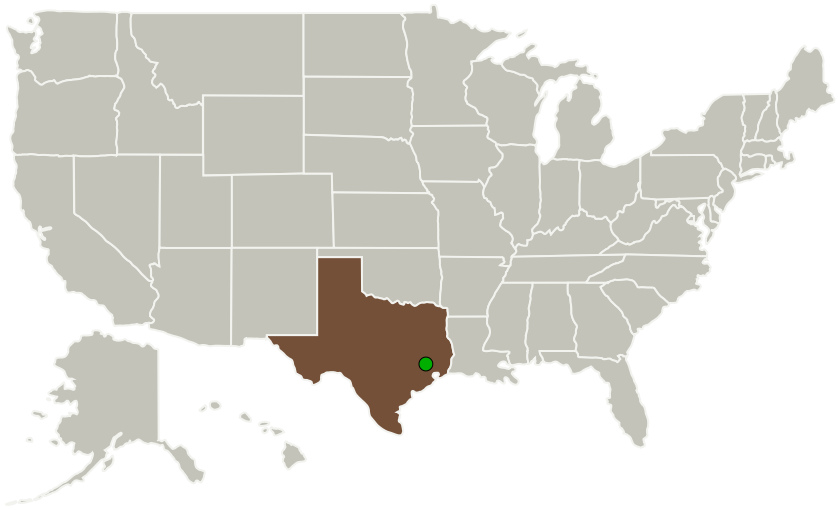
ADAMANT: Adaptive Manipulation for Tasks, Phase I

Table of Contents

ADAMANT: Adaptive Manipulation for Tasks, Phase I

Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
TRACLabs, Inc.	Lead Organization	Industry	Webster, Texas
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations
Texas

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140897)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

TRACLabs, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

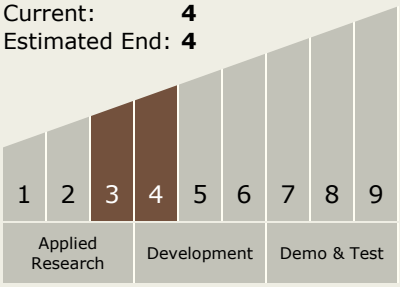
Carlos Torrez

Principal Investigator:

Robert R Burridge

Technology Maturity (TRL)

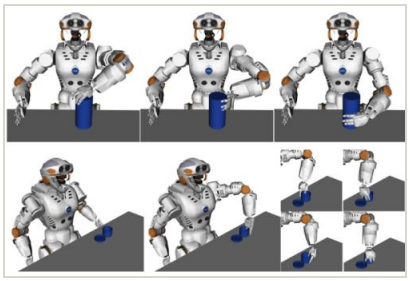
Start: **3**
Current: **4**
Estimated End: **4**



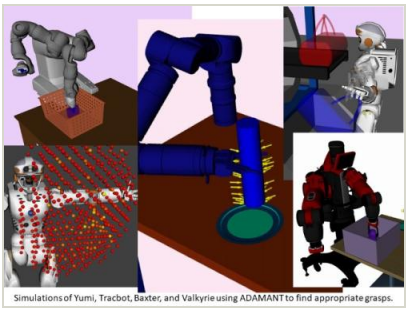
ADAMANT: Adaptive Manipulation for Tasks, Phase I

Completed Technology Project (2018 - 2019)

Images



Briefing Chart Image
ADAMANT: Adaptive Manipulation for Tasks, Phase I
(https://techport.nasa.gov/image/127642)



Final Summary Chart Image
ADAMANT: Adaptive Manipulation for Tasks, Phase I
(https://techport.nasa.gov/image/131700)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.2 Grappling Technologies

Target Destinations

Earth, The Moon, Mars